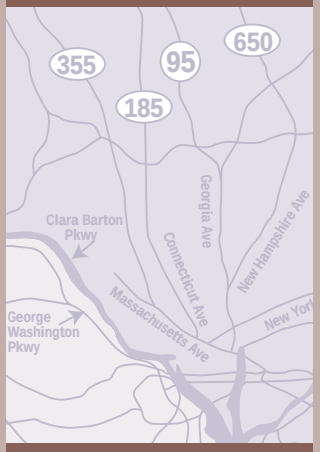
chapter 4



WHAT HAVE WE LEARNED ABOUT ADVANCED TRAVELER INFORMATION SYSTEMS AND CUSTOMER SATISFACTION?

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EXECUTIVE SUMMARY

This paper synthesizes customer satisfaction findings from advanced traveler information systems (ATIS) research and evaluations dating from 1996.[1] Recent project evaluations from the Metropolitan Model Deployment Initiative (MMDI) in Seattle, San Antonio, and Phoenix are featured more prominently because these deployments provided a natural use setting and thus a more reliable context for assessing customer satisfaction.

For purposes of this paper, ATIS is defined in two ways: (1) real-time network information, whether traffic or transit; and (2) traveler information, such as route guidance or destination information, provided on advanced technologies, such as mobile phones enabled by wireless application protocol (WAP), personal digital assistants (PDAs), the Internet, and in-vehicle computers. This paper's focus is on public sector ATIS services, although one section does address ATIS business models, with selected private services included in that discussion. Content is constrained by the availability of ATIS customer satisfaction evaluations, placing certain ATIS applications beyond the scope of this paper, along with the ability to provide a general overview of the state of the art or practice of ATIS products and services.

Evaluation findings suggest that customer demand for ATIS traffic services is based on four factors: (1) the regional traffic context, (2) the quality of the ATIS services, (3) the individual trip characteristics, and (4) the characteristics of the traveler. The regional traffic context includes attributes of the region, such as highway-roadway network and capacity, levels of traffic congestion, and future highway-roadway expansion plans. Information quality determines whether, how frequently, and with what level of confidence travelers consult traveler information. The trip purpose, the time and length of the trip, and the particular route or route choices available to the individual traveler all significantly affect whether individuals consult traffic information. The fourth factor includes user values and attitude characteristics, which are important determinants of use patterns, behavioral responses, and valuation of ATIS.

Conditions predicting high demand for ATIS transit services are not as well studied, but appear to be related to the complexity and variability of the transit network, the age of the transit rider population, and the level of technological sophistication of riders.

Drivers report that they consult ATIS to assess traffic congestion on their routes, decide among alternate routes, estimate trip duration, and time their trip departures. They regularly change their trips or their trip expectations based on traffic congestion information. ATIS customers identify four primary benefits of the service: saved time, avoided congestion, reduced stress, and avoided unsafe conditions.

[1] In 1996, a report was prepared by Dr. Christine Johnson for Charles River Associates and John A. Volpe Transportation Systems Center summarizing all ATIS user acceptance evaluation and research performed to that point. *User Acceptance of ATIS Products and Services: A briefing book on the current status of JPO research* (March 1996) summarized findings from the U.S. DOT-sponsored field operational tests and traveler decision and behavior research performed in the 1960s. Findings from this study formed the research and evaluation framework pursued through the ITS User Acceptance Research program and the Metropolitan Model Deployment Initiative customer satisfaction evaluation. This paper builds on findings of the earlier study.

All travelers agree that ATIS services must provide accurate, timely, reliable information, and be safe and convenient to use. Drivers with experience using ATIS provide a more detailed and informed set of customer requirements. They seek the following:

- Camera views that portray road conditions.
- Detailed information on incidents.
- Direct measures of speed for each highway segment.
- Travel time between user-selected origins and destinations.
- Coverage of all major freeways and arterials.
- En route access to good traffic information.

ATIS transit customers want services that provide real-time information both pre-trip and en route, a good quality user interface, and convenient access to detailed system information. Customers cite the following benefits of transit ATIS: reduced stress, improved satisfaction with the decision to take transit, and greater control over time and travel decisions.

Kiosks and WinCE mobile computers, deployed and evaluated as part of the MMDI, did not prove to be popular ATIS venues for traffic or transit information. For kiosks, the problems included poor placement in relation to the trip decision, unreliable performance, and a challenging user interface. Traffic and transit information on mobile hand-held computers received little notice from travelers. This circumstance may have been related to low market penetration of the WindowsCE devices and insufficient promotion of the new traveler information services.

Drivers who watched traffic reports on cable television community access channels in Seattle and Tempe, Arizona, found the television broadcasts to be more useful than traffic reports on the radio. However, overall response to the surveys was weak, suggesting low viewership. A partial explanation may be the lack of program advertising, as most respondents reported learning about the broadcast when "channel surfing."

In-vehicle navigation systems have yet to reach their predicted level of market penetration. Currently, they are available in rental cars and as an option in luxury cars; however, the number of auto manufacturers with the navigation system option is expected to double in model year 2001. Developers insist that the product will not achieve full market potential until real-time traffic is integrated into the routing algorithm.

The business model for delivery of and payment for ATIS traffic services is still in flux. ATIS companies face multiple challenges. Traffic data must be collected by individual agreement with each state and every transportation authority across the country. The data are variable in scope and quality, and there is no established consumer market. In-vehicle personal computers (PCs) and navigation devices, an important venue for sale of traffic information services, have been slow to market. The geocode used by one major traffic information supplier to identify the location of traffic is inconsistent with the geocode embedded in another major manufacturer's

map database and navigation software. Venture capitalists are hesitant to invest in companies whose product depends on government resources or cooperation. Not surprisingly, none of the private sector ATIS businesses dealing in traffic information services in the United States have made a profit on that service.

If current operational tests prove that mobile phones can be used as traffic probes, businesses may be able to contract with one primary source for standardized traffic data, and mobile phone traffic data will reduce or remove ATIS businesses' dependence on public sector data sources, improving their ability to attract private investment.

Current market trends suggest that an increasing proportion of all employed Americans will carry some form of mobile telecommunications device. This circumstance creates a good business opportunity for information service providers. Assuming that ATIS companies can address the issues currently confronting them, ATIS services will be included in mobile information subscription packages. Recent Federal Communications Commission (FCC) enactment of a national three-digit traveler information number (511) should further accelerate customer use of ATIS. Automotive companies are developing integrated in-vehicle information systems, which will connect all aspects of the auto's maintenance and operating systems with Internet access, entertainment and productivity programs, and mobile two-way voice and data exchange. Consumer interest in the in-vehicle system is expected to be high. Taken as a whole, these trends suggest that more consumers will be exposed to telematic services and have the opportunity to use an ATIS service. Customer satisfaction with ATIS and long-term use will depend on the quality of the information.

This summary identifies many ATIS deployment issues that merit further investigation. The hypothesis developed to explain consumer response to ATIS is drawn from a very small and idiosyncratic sample of regions. An issue made prominent by its absence is customer satisfaction with ATIS transit information, and its ability to influence mode choice. Such data are critical to transit authorities' ATIS investment decisions. Finally, several promising ATIS applications suffer from lack of publicity. Now that ATIS benefits are sufficiently well documented, it may be useful to "field test" an advertising campaign for its ability to attract new ATIS consumers.

The following table summarizes deployment levels and relative levels of success for selected ATIS services. The data are drawn from the Metropolitan Intelligent Transportation Systems (ITS) Deployment Tracking Database.[2] Comments also draw from work prepared for the February 2000 workshop addressing the ATIS data gap.[3] The Intelligent Transportation Society of America (ITS America) and the U.S. Department of Transportation (U.S. DOT) jointly sponsored the workshop, held in Scottsdale, Arizona. For purposes of this paper, "success" when applied to an ATIS service means that the service is well subscribed by the consumers it was designed to serve.

[2] The three different deployment levels are defined as follows: Deployed in fewer than 10 percent of the largest 78 metropolitan areas = Limited Deployment; Deployed in between 10 percent and 30 percent of the largest 78 metropolitan areas = Moderate Deployment; Deployed in more than 30 percent of the largest 78 metropolitan areas = Widespread Deployment

[3] Specifically, *Features of Traffic and Transit Internet Sites*, Jonah Soolman and Sari Radin, and *Advanced Traveler Information Service: Private Sector Perceptions and Public Sector Activities*, Sari Radin, Basav Sen, and Jane Lappin, John A. Volpe Transportation Systems Center, Cambridge, MA.

Table 4-1. ATIS Summary Table

ATIS Service	Deployment Level	Limiting Factors	Comments
Real-time traffic information on the internet	Widespread Deployment	While deployment is widespread, customer satisfaction with the services seems related to local traffic conditions and website information quality	**Mixed**—the characteristics of the websites vary, depending on the availability and quality of the user interface and underlying traffic data.
Real-time transit status information on the Internet	Limited Deployment	Transit authorities have limited funds for ATIS investments and little data that establish a relationship between ridership and ATIS	**Holds promise**—where the service is available, reports suggest that there is high customer satisfaction with the service
Static transit system information on the Internet	Widespread Deployment		**Successful**
Real-time traffic information on cable television	Limited Deployment	Limited by information quality and production costs, although one service provider has developed a way to automate production	**Successful**—as evaluated in a highly congested metropolitan area where consumers value the easy, low-tech access to traffic information
Real-time transit status information at terminals and major bus stops	Limited Deployment	Cost	**Successful**—where evaluated in greater Seattle
Dynamic message signs	Widespread Deployment	Positive driver response is a function of sign placement, content, and accuracy	**Successful**—drivers really appreciate accurate en-route information
In-vehicle navigation systems (no traffic information)	Limited Deployment*	Purchase cost	**Holds Promise**—as prices fall, more drivers will purchase the systems
In-vehicle dynamic route guidance (navigation with real-time traffic information)	No commercial deployment; the San Antonio MMDI installed prototype systems in public agency vehicles*	Irregular coverage and data quality, combined with conflicting industry geocode standards, have kept this product from the market	**Holds Promise**—manufacturers are poised to provide this service once issues are resolved
Fee-based traffic and transit information services on palm-type computers	Unknown Deployment	Service providers make this service available through their websites, actual subscription levels are unknown	**Jury is still out**—requires larger numbers of subscribers becoming acclimated to mobile information services

** Quantitative deployment tracking data not available. Deployment level determined by expert judgment.*

INTRODUCTION

In 1996, an ATIS user acceptance research and evaluation retrospective was prepared that summarized findings from the traveler behavior literature of the 1960s and from the U.S. DOT-sponsored ITS field operational tests. This paper picks up from there, synthesizing findings from ATIS user-response research and customer satisfaction evaluations dating from 1996, including several field operational tests. Recent project evaluations are featured more prominently because they offered ATIS services to the general public for regular use, thus providing a more natural and more reliable context for assessing customer satisfaction.

This paper draws primarily from the following sources:

- MMDI customer satisfaction evaluations of the Puget Sound traffic conditions website.
- TrafficTV in Seattle.
- Metro Online transit website in Seattle.
- TransitWatch® real-time bus departure times at two transit centers in Seattle.
- TrafficCheck traffic television in Tempe, Arizona.
- Focus groups with drivers along highway segments equipped with dynamic message signs in San Antonio.
- Observations of customer use of the Trailmaster travel conditions website in Phoenix.
- Transguide travel conditions website in San Antonio.

Only two ATIS transit services were deployed within the MMDI evaluation time frame. Similarly, there were fewer ATIS transit field operational tests than traffic tests. As a result, this paper addresses more ATIS traffic services than transit or multimodal services.

Note: In most instances where the term "ATIS" is used, it refers to a traffic or transit information service providing consumers with access to real-time network conditions.

EXTERNAL CONTEXT INFLUENCES ATIS CUSTOMER RESPONSE

Findings from the MMDI evaluation and other research suggest that customer demand for ATIS traffic services stems from four factors:

- Regional traffic context.
- Quality of the ATIS services.
- Individual trip characteristics.
- Characteristics of the traveler.

Regional traffic context includes attributes of the region, such as highway-roadway network and capacity, levels of traffic congestion, and future highway-roadway expansion plans. Prime ATIS markets appear to be highly congested regions with

limited build-out options, constrained alternate route possibilities,[4] and frequent unpredictable traffic events (e.g., weather, crashes, overturned truck).

Quality of ATIS services is at least as important as the level of network congestion. Information quality determines whether, how frequently, and with what level of confidence the traveler consults traveler information. Quality also determines whether the information will meet customer needs with respect to personal benefit and value.

Trip purpose, time of trip in relation to peak congestion periods, trip length, and particular route or route choices available to the traveler all have a significant effect on whether he or she consults traffic information. To a limited extent, the availability and convenience of alternative mode choices for a given trip affects ATIS use. Departure time flexibility, or lack thereof, is another determinant in the choice to consult traffic information.

The fourth factor considers the values and attitudinal characteristics of the user, or potential user, of ATIS products and services. These characteristics are important determinants of user awareness, use patterns, behavioral responses, and valuation of ATIS. For example, user attitudes toward timeliness affect response as do user preferences, such as a desire to be in touch at all times, or to ask a person for assistance rather than use a computer.

Fewer opportunities have existed to assess transit customer response to ATIS services. Conditions that suggest high demand for ATIS transit services appear to be related to the complexity and variability of the transit network, the age of the transit rider population, and the level of technological sophistication of the riders. Younger riders expect transit information to be as easily accessed as that provided by any market-based service. Their expectations are probably conditioned by the current service economy and by information available on the Internet. Technologically sophisticated riders are aware of many of the tools available for tracking cars and buses, and can easily imagine the personal benefits of real-time transit status information, in addition to the other services that advanced media can provide.

ATIS CUSTOMERS[5]

Almost all ATIS customers are employed commuters, with the greatest use of ATIS occurring during peak commuting hours. More ATIS traffic customers are male, but among ATIS transit customers, use rate by gender is about even. Based on the MMDI survey trends, primary demographic factors are the ATIS customers' mode of

[4] The hypothesis that a constrained set of alternative routes is a positive factor for ATIS acceptance is based on a comparison of the three evaluated MMDI sites: San Antonio, Phoenix, and Seattle. Drivers seem most concerned about knowing traffic conditions in networks where they have limited alternative route options and thus must plan ahead for route diversion. Where the network offers many possible alternate routes, drivers seem more sanguine about diverting after they have encountered the congestion, without need of advance information for trip planning.

[5] For more details on the segmentation of the ATIS consumer market, see "Who are the likely users of ATIS? Evidence from the Seattle region", S.R. Mehndiratta, M.A. Kemp, J.E. Lappin, and E. Nierenberg, paper number 001103, presented at the 79th meeting of the Transportation Research Board, Washington, DC, January 2000. Also see "A Profile of the Emerging ATIS Consumer: Evidence from the Metropolitan Model Deployment Initiative Sites" by S.R. Mehndiratta, et. al. (Winter 2000), *ITS Quarterly*.

transport, commute trip characteristics, level of education, age, and comfort with advanced technology.

ATIS market segmentation based on attitudes and values related to the need for control, the value of time, personal travel preferences, and use of advanced technologies successfully identifies much of the current ATIS customer market, differentiating ATIS customers from others with similar demographic characteristics. To help characterize and identify these segments, they were labeled as control-seekers, webheads, or pre-trip information seekers.

Control-seekers dominate the ATIS customer market. In addition to high technology and gadget use, this segment is also defined by high use levels of portable devices like laptops and cellular phones. These customers consult ATIS to save time, to use their time efficiently, to stay on schedule, and to stay informed. Control-seekers use information more intensively than the general population.

Webheads comprise the second largest group of ATIS customers. This group is the most technologically savvy in the sample. Its members are marked by high computer and Internet use, both at home and at work. However, their interest appears linked to the Internet medium and may not migrate to mobile platforms as Web-based information becomes mobile.

Individuals in the low-tech, pre-trip information seekers market segment have a low acceptance and comfort level with the Internet and Web-based information. Consistent with this characterization, individuals belonging to this segment comprised much larger shares of the Transit Watch, TrafficTV, and TrafficCheck user populations—all three information services delivered on television or by means of a television-style monitor. This group is older, includes slightly more males than the sample, and is generally somewhat less comfortable with technology. For example, members of this segment prefer to ask a person for information rather than rely on a computer. Nevertheless, this customer segment represents a large portion of the current ATIS customer pool and can be expected to continue to demand high quality information services on low-tech media in the future.

WHY DRIVERS CONSULT ATIS AND HOW THEY USE IT

Drivers consult ATIS to reduce trip uncertainty. They want to lessen the impact of traffic congestion delay and aggravation, and increase their control over time. Washington Department of Transportation (DOT) traffic website customers consulted the site for five reasons, representative of those offered by most ATIS users. They are listed here in order of importance:[6]

- To assess traffic congestion on their routes.
- To judge the effects of incidents on their trips.
- To decide among alternate routes.
- To estimate their trip duration.

[6] From May 11 through June 8, 1999, a banner on the Wisconsin DOT traffic website invited users to respond to an on-line survey to help improve the website. A total of 608 users completed the questionnaire.

- To time their trip departures.

Drivers using ATIS report that they regularly change their trip or their trip expectations based on traffic congestion information. For instance, they:

- Change time of departure.
- Change part or all of their route of travel, potentially lengthening trip mileage or duration.
- Adjust their expectations, listen to an audiotaped book, bring an extra compact disc, make phone calls, reschedule appointments, and/or make alternative arrangements.

They reported four primary personal benefits from their use of the Wisconsin DOT traffic website (in order of importance):

- Saved time.
- Avoided congestion.
- Reduced stress.
- Avoided unsafe conditions.

These use patterns, behavioral responses, and benefits are similar among all drivers surveyed as part of the MMDI ATIS evaluations. In the following section, critical features identified by ATIS customers refer back to decisions the information supports and the benefits it provides.

CRITICAL FEATURES OF AN ATIS TRAFFIC SERVICE

The National ITS Program fielded qualitative market research in 1996 on various traffic information concepts with drivers in congested regions (Charles River Associates 1997).[7] While the opinions of these drivers were based on their experience with radio broadcast traffic information, their traffic information concerns have proven to be true of all drivers surveyed since. Survey respondents were (and are) concerned with:

- Accuracy.
- Timeliness.
- Reliability.
- Cost (capital and operating).
- Degree of decision guidance and personalization.
- Convenience (ease of access and speed).
- Safety (of operation).

Surveys of drivers with long-term personal experience using ATIS through the Web, by telephone, on a prototype in-vehicle device, or on cable television provide a more detailed and informed set of customer requirements. These requirements, which help to define ATIS service quality, are discussed below.

[7] Twelve focus groups (two in each location) were fielded in New York City, Washington, D.C., Boston, Philadelphia, Los Angeles, and Orange County, California.

Camera Views

All respondents value the video camera views displayed on websites and cable television.[8] Video camera views provide drivers with the opportunity to exercise their own judgment of the road's conditions. For every service that provided video camera views, survey respondents asked for a time stamp, a clear description of the camera's location, and its direction. Some website respondents observed that camera images were slow to load on their computers, and others commented that on some sites the cameras were frequently out of order. These service problems lessened consumers' interest in using traffic websites. Respondents also asked for clearer images, especially during inclement weather.

Information on incidents

Drivers want detailed and up-to-date information on incidents. They use this information in combination with their own experience of the road network to estimate the intensity and duration of incident-related traffic congestion. They want to know exactly where the incident occurred, at what time, and the type of incident. They also want to know the impact of the incident on traffic speeds, both on the road where the incident occurred and on adjacent area roads. For services that provide color-coded congestion maps, such as the Wisconsin DOT, some drivers wanted to see icons indicating that an incident had occurred, and to be able to click on that icon for further details. Others found icons distracting, but wanted to be able to move their cursor over the map, observe whether there were incidents underlying congestion, and then click for details.

Direct measures of speed for each highway segment, and travel time between user-selected origins and destinations

When selecting among alternate routes, most drivers want to know which route will get them to their destination most quickly. This preference suggests that the service provide either time of travel between two points or direct measures of speed for each highway segment. While many respondents wanted both, more frequent users of the Wisconsin DOT website rated direct measures of speed as more important. Graphically represented traffic speed and volume were also very important service features to TrafficTV viewers.

Dynamic route guidance

Are drivers more interested in receiving dynamic route guidance, or do they prefer advisories of traffic delays that allow them to exercise judgment in selecting an alternate route? There are several answers to this question (Schofer, Koppelman, and Charlton 1997). First, in general, women are somewhat more likely to accept dynamic route guidance, while men prefer delay advisories. It appears that most drivers believe they can select better alternate routes for their local areas than any service could provide. Others prefer to set a delay threshold and receive dynamic route guidance for any traffic event that exceeds their threshold, particularly true for

[8] One service provider remarked that when her company added camera views to their website, usage of the site doubled.

drivers in unfamiliar areas. Finally, drivers become more accepting of dynamic route guidance if, through use, they find that it gives good advice.

Coverage

Survey respondents want ATIS coverage of all major freeways and arterials in their region, along with information on high-occupancy vehicle (HOV) lanes and express lanes in the region. However, this preference may be a function of the regional road network where the surveys were fielded and the types of services evaluated. Specifically, in greater Seattle, most of the traffic congestion is on the freeways and major arterials. Further, the services cover primarily freeways, so potential customers are drivers who would find that information useful, not drivers who commute primarily on local streets. In contrast, drivers in suburban Chicago wanted more information on local streets. The sensible conclusion from these data is to provide traffic information according to local driving patterns, and to prioritize coverage by market demand, providing it first on roads with the most congestion.

Timing of information updates

While the surveys did not explore the exact timing required for traffic condition updates, drivers in Seattle felt that traffic conditions in their region were sufficiently dynamic to justify frequent updates, particularly along heavily congested roads, during peak traffic hours, and along critical segments such as the bridges. In Phoenix, website users complained that camera images, in particular, were not updated frequently enough. Generally, all ATIS customers want to know when the service was last updated, and will use the interval to estimate current traffic conditions.

Mobile ATIS

Drivers want reliable, accurate, relevant traffic information while driving. For many trips, pre-trip traffic information is outdated by the time the driver reaches a potential route diversion decision. This situation is where the greatest demand for ATIS currently exists, more so than pre-trip. Drivers recognize the safety challenge of delivering information to them, and most respondents expressed safety concerns about mobile phone use when driving. Nevertheless, drivers want to be able to press an ATIS button when approaching congestion or a route choice and quickly know which route would be least congested.

Local weather conditions

Weather affects traffic conditions. In Seattle and San Francisco, where microclimates create different weather conditions in neighboring cities, drivers want to know what to expect. In Boston and Minneapolis, severe weather conditions have a profound impact on traffic. Heavy rains affect driving conditions in San Antonio, and dust storms stop traffic in Phoenix. Nearly all drivers surveyed want appropriate, relevant weather conditions included with their traffic information. Bad weather is another form of incident, and drivers want to know when the weather affects road conditions, but do not value the information if there is nothing significant to report.

User interface and operating characteristics

User comments on interface and operating characteristics are a function of the platform used to convey the information. Website users are particularly aware of the multidimensional information opportunities presented by the Web, and are especially sensitive to the problem of computer and Internet speed. Currently, most Web users access the Internet at work and thus have fairly fast connections to websites. But lack of quick access to the Internet is one reason more commuters do not check the traffic website in the morning. Slow downloading of images also frustrates Web users, whose expectations for computing speed may outstrip the capabilities of the website's servers, especially if the site's capacity is overburdened at rush hour or during inclement weather. Dedicated users will stay with a Web service that is occasionally slow, but marginal users may not.

Both Web users and television (TV) viewers require clear and uncluttered visual presentation of information. Traffic congestion maps that use green, amber, and red to suggest traffic speeds are ranked higher for ease and speed of comprehension. Graphics must be large enough to see easily on television screens of different sizes and resolutions. Most television viewers want the screen image to be supplemented by an audio voiceover description of traffic conditions and suggestions for alternate routes when freeways are congested.

Because phone service users are frequently phoning from the road, they require fast and easy access to information. New voice recognition software that would let callers tell the service which road segment or region to describe would be a great improvement over push-button information trees, particularly for drivers. Advertising, which appears on some telephone ATIS services just before the traffic information is provided, interferes with the speed of information delivery and irritates customers.

ADDITIONAL SUGGESTIONS FROM ADVANCED ATIS TRAFFIC SERVICE USERS

The quality and popularity of the Washington State DOT traffic website in Seattle created an opportunity to survey a small number of especially advanced ATIS users who made much more intensive use of the site than average customers. These users provided expert suggestions for website improvements likely to be predictive of the improvements that average customers will seek in the near future. Further, these suggestions may represent the type of improvements that help customers differentiate between a service they can access free of charge and services that offer added value sufficient to merit a fee.

Ramps

Seattle meters its freeway ramps, and during peak hours some ramps have far greater backups than others do. Advanced users would like to choose among possible on-ramps for the shortest possible queue.

Trends

Advanced users have discovered that one can predict trends based on a time-series sample of current traffic conditions. They accomplish this result by repeated checking of conditions over a period of 15 or 30 minutes. They suggest that it would be useful for the service to state whether conditions are currently getting worse, or whether they are improving.

Predictive information

Predictive information refers to both near-term traffic predictions based on current conditions, and forecast conditions, based on what can be expected on average for certain times of the day, days of week, or weather conditions.

Because traffic conditions are dynamic, a route that looked clear at time of departure may be severely congested 10 or 20 minutes into the trip. Advanced users recommend that ATIS use current information in combination with historic data to provide customers with near-term predictive information on their route conditions. Drivers can then make en route choices using "current" information instead of information that was current at the time they started out.

Archived traffic information can forecast traffic conditions, enabling customers to plan ahead. For example, upon approaching the Labor Day weekend, MetroCommute of Greater New York advised its customers to plan on departing the city at 5 p.m. Friday for the best travel times to vacation areas. And, in a retrospective analysis, a 5 p.m. departure from the city provided drivers with the best trip time of the day.

Windows of opportunity

Advanced users have observed the existence of periods of relatively uncongested travel that appear in the midst of traffic congestion, even during peak hours. They would like to see these windows of opportunity identified by the ATIS service.

Flash major events on the map

Major events are like incidents in their impact on traffic congestion. Advanced ATIS users would like to be reminded of an impending event through a visual cue on the traffic map, with details provided by cursor or double click. Users in Seattle suggested, for example, a flashing King Dome icon on evenings when there is an event at that venue.

Parking information

Many cities have insufficient downtown parking to accommodate peak demand. Advanced users would like to know which lots have availability and which are full, to avoid driving around in congestion, searching for a space. Some respondents suggested they would switch modes when parking lots were full. This service would be more valuable to customers if it were coupled with an advanced parking reservation and payment system.

CRITICAL FEATURES OF AN ATIS TRANSIT SERVICE

Transit customers seek to lower the trip time uncertainty they commonly experience with transit. They want information that increases their control over time and travel decisions.

Evaluation findings indicate that ATIS transit customers want services that provide real-time information both pre-trip and en route, good quality user interface, and convenient access to detailed system information. Customers cite the following benefits of transit ATIS:

- Reduced stress.
- Improved satisfaction with the decision to take transit.
- Greater control over time and travel decisions.

Because one of the two major transit ATIS evaluations—MMDI—was Web-based, many of the user suggestions below refer to website enhancements.

Real-time transit information on Web, by phone, at bus stops, and on monitors at malls and office parks near major transit centers

Transit riders would like more and better information on location and arrival/departure time of their bus, and on any connecting bus their trip may require. They would like convenient access to the information through a variety of media and at bus stops. Some respondents suggested an abbreviated key sequence for mobile phone users that would connect directly to an automated bus status line, similar to mobile phone services offered for traffic information. Other respondents felt that it would be useful to have real-time bus information provided on monitors in nearby shopping malls and office buildings.

More sophisticated and detailed Web interfaces

Transit riders who are Internet users would like to see transit websites that fully exploit the potential of the Web to use multiple information dimensions. Survey respondents complained about two-dimensional sites whose pages function like pages in a book and do not take full advantage of the medium's capabilities.

Point-to-point itineraries (Web)

Riders would like to be able to enter origin and destination, whether by point-and-click on a map, or through addresses or landmarks, and receive a detailed, printable transit trip itinerary, including travel time, relevant fares, and schedules.

Point-to-point itineraries for multi-modal trips (Web)

Similar to the request above for transit trips, riders would also like to receive trip itineraries that incorporate other modes of travel.

Recommended trip times and routes for fastest travel (Web)

Some transit riders expressed a desire to be able to enter their origin and destination and be told which times of day and which bus routes would get them to their destination in the least amount of time.

Detailed maps of routes, with stops, and transfer locations (Web)

In Seattle, focus group participants described the difficulty of being able to interpret from a route map or schedule where the bus stopped, and, in particular, where to go for the transfer bus. They would like access to more detailed street maps showing exactly where each bus stops.

Secure on-line bus pass purchases (Web)

Customers would like a secure way to purchase transit passes on-line, rather than travel to a transit center to purchase passes in person.

WHICH ATIS SERVICES AND VENUES HAVE NOT WORKED AND WHY

Unsuccessful ATIS traffic applications[9]

Traffic kiosks

Kiosks and WinCE mobile computers, as deployed and evaluated for the MMDI, did not prove to be popular ATIS venues for traffic information. For kiosks, the problems included poor placement in relation to the trip decision, unreliable performance, and a challenging user interface. Customer interest in traffic information on kiosks seems to improve where the kiosk offers additional services and information.

Two other consumer information venues were abandoned in 1995 following earlier market deployments: faxed traffic reports and single-purpose in-vehicle traffic information devices. The lack of consumer response to faxed traffic reports can likely be attributed to a variety of factors, including new product inertia, low-quality information, and insufficient marketing. Single-purpose in-vehicle traffic information devices, regardless of platform, suffered from poor-quality information relative to cost, premature marketing, and consumer resistance to single-purpose electronic devices.

The jury is still out: Current ATIS traffic applications

Cable television (as deployed and evaluated)

Traffic information was broadcast on cable community access channels as part of the MMDI in Seattle and Phoenix. Response to the surveys was not strong, which may be a function of low viewership. Most respondents reported learning about the broadcast when channel surfing. Commercial television ratings do not include such stations, so there is no way to know actual viewing levels. Traffic information on television will likely develop into a more valuable venue for travelers, especially for the morning commute trip, as marketing improves viewer awareness of the broadcast and user interface quality is improved.

Survey respondents who were viewers found the service more useful than traffic information on the radio. For those people who are traffic information consumers, as with many respondents in Seattle, TV fills a “low-engagement” niche: very little

[9] These applications were unsuccessful as evaluated in the context of the MMDI; they may be successful in other settings or in the future.

effort is required to turn on the television and absorb the message. In contrast, the Internet is frequently a "high-engagement" medium because of the time and attention required to boot a computer, connect to the Internet, open the website, and find the needed information. The value of the service is linked to the quality of information, including coverage and presentation. More viewers watch in the morning than in afternoon, and there appear to be more viewers in the more congested region of Seattle as opposed to Tempe, Arizona, which has far lower congestion levels.

Traffic information on WinCE mobile computers

Traffic information on mobile hand-held computers was available as part of the MMDI in Seattle and Phoenix, but received little notice from travelers, probably because of low market penetration of the WindowsCE devices and insufficient marketing and promotion of the new traffic information services. This venue for traffic information should be reconsidered with better market conditions and should become a more popular venue as wireless communications improve.

In-vehicle navigation devices (as observed)

In-vehicle navigation systems are available primarily in rental cars and as an option in luxury cars, including those made by Range Rover, BMW, Porsche, and Jaguar. The number of car manufacturers with the navigation system option is expected to double from the 2000 to the 2001 model year. A low level of customer demand beyond these markets stems from high price/value ratios for most drivers. Some demand exists for units in the aftermarket, but manufacturers find current sales levels disappointing. Developers insist that the product will not achieve market potential until real-time traffic is integrated into the routing algorithm. Ultimately, navigation and route guidance will be part of broader functioning in-vehicle information systems.

The jury is still out: ATIS transit applications[10]

Kiosks

As with traffic information, kiosk-based transit services (as deployed and evaluated) suffered from frustrating user interface, unreliable performance, and no marketing. Examples may exist of transit information kiosks located in pedestrian areas, convenient to the transit system entrance, that provide riders with useful information; however, few evaluations have been made of kiosks as ATIS venues. Therefore, transit kiosks should not be abandoned as an information platform based on evaluation findings to-date.

WinCE mobile hand-held computers

Mobile hand-held computers as platforms for transit information (as deployed and evaluated) suffered from low market penetration of devices and insufficient marketing and promotion of services. Once mobile two-way computers and telephones become more functional and more common, the platform should provide those riders who own them a convenient method for accessing real-time transit information.

[10] These transit applications were unsuccessful as evaluated during the MMDI evaluation period, 1997-1998; they may be successful in another context or at another time.

ATIS BUSINESS MODELS: A WORK IN PROGRESS

Business models for delivery of and payment for ATIS services are still in flux. Currently, ATIS is one component of the much larger information services business. The telematics business considers ATIS traffic information (but generally not transit information) as one of several mobility services included with navigation, concierge services, personal safety, and security. Understanding has evolved over the past decade of how ATIS would be sold, in response to several factors, including changes in the underlying technology, our understanding of the customer, and, in the case of the Internet, the basic business proposition.

Currently, approximately a dozen private companies are seeking to "package" traffic information and sell it at a profit to consumers. Some of the companies are closer to the raw traffic information data and make their business by creating a standardized traffic information product to sell to information service packagers and retailers, such as I3, OnStar,™ and ATX. A subset of traffic information companies supplements public sector traffic data with proprietary data obtained with cameras, private probes, and aircraft. Approximately a half dozen companies are also working to sell ATIS directly to consumers, primarily through the Internet. The Web-based companies have a two-part approach: (1) making general traffic information available free on their websites, usually combined with advertisements; and (2) providing customers interested in more tailored traffic information subscription services with personalized traffic alerts delivered at the times and on the media of their choosing. Also on the retail side of the business are manufacturers of in-vehicle information systems and navigation devices, as well as on-line navigation services like MapQuest, Telcontar, and Rand McNally, which seek to offer their customers the added dimension of real-time traffic route guidance.

ATIS companies face multiple challenges:

- The underlying "product"—real-time traffic information—cannot be manufactured in a controlled environment; instead, it must be collected by individual agreement with each state and transportation authority, or in some cases with private companies, across the country.
- The data are variable in scope and quality and are provided in nonstandardized formats. This condition creates an obstacle for information wholesalers and telematics service companies who require that their consumer services be uniform in quality and available nationwide.
- No established consumer market exists for real-time traffic information other than radio broadcast reports.

While the tools used to measure and record traffic data have remained relatively stable until now, the media used to communicate with consumers has changed dramatically over the past five years, perhaps improving market opportunities for ATIS, but almost certainly diverting companies' product development resources.

Telematics platforms, such as in-vehicle PCs and navigation devices—an important venue for sale of traffic information services—have been slower than expected to

market, and much slower to reach middle market prices needed for more popular customer acceptance.

The geocode used by one major traffic information supplier to identify the location of traffic is inconsistent with the geocode embedded in another major manufacturer's map database and navigation software. This problem is currently being addressed in an ITS America telematics industry forum.

An uncertain profit horizon has constrained private investment in ATIS businesses. Competition for venture capital is fierce, and the best ranked opportunities have established consumer demand, a standardized product, and no dealings with government agencies. Because government is not motivated by the same market logic as business, venture capitalists are hesitant to invest in companies whose product depends in any measure on government resources or cooperation.

Thus far, the bulk of funds invested in the development and dissemination of ATIS have come from the public sector, and none of the private sector ATIS companies dealing in traffic information services have made a profit on that service in the United States.

Proof through current operational tests that mobile phones can function as traffic probes will significantly affect the ATIS business model. First, it creates the opportunity for a national, standardized source for traffic information. This circumstance will provide businesses with the possibility of contracting with only one source for traffic data, rather than the myriad sources tapped now. It may solve the problem of variable service quality. If successful, it will reduce ATIS operating costs, although some of the cost will shift to purchasing data. And, of particular importance to the growth and development of this business niche, mobile phone traffic data will reduce or remove ATIS businesses' dependence on public sector data sources and improve its ability to attract venture capital and other private investments.

WHAT THE FUTURE MAY HOLD

The Internet has had the effect of increasing consumers' expectations of information availability, quality, and responsiveness. This effect is readily seen among ATIS website customers, who are encouraged by sites that continually improve functionality and features, and are likely to stop consulting websites that do not. Each month, additional households invest in Internet connections. As a consequence, it is likely that all types of services will establish websites to communicate with customers. To attract and retain Internet customers, ATIS sites must improve in line with the medium as a whole and with customers' expectations.

Several new venues for ATIS traffic and transit services are emerging on the market: mobile hand-held computers, Internet phones, and in-vehicle information systems. All three will rely on the evolution of the WAP currently under development and endorsed by the telematics industry. It will enable mobile, direct two-way wireless access to the Internet, which will simplify the current wireless information delivery path to customers and enable faster personalized Internet access. The market penetration of these devices is expected to be significant.

On July 21, 2000, the FCC assigned a national three-digit traveler information number, 511, to give callers quick access to traffic and transportation information. Advocacy for a uniform, national three-digit access code came from both public and private sectors, with the expectation that one uniform, national access number would improve customer service and reduce operating and marketing costs. U.S. DOT has made $5 million available to states for conversion to 511. ATIS service providers anticipate that 511 will help to increase customer awareness and use of ATIS services nationwide.

Integrated in-vehicle information systems are envisioned to connect all aspects of the automobile's maintenance and operating systems with Internet access, entertainment and productivity programs, and mobile two-way voice and data exchange. In addition to WAP, two recent industry protocols enable this service: the ITS Data Bus (IDB) will provide plug-and-play standards for in-vehicle telematics applications, while the Automotive Multimedia Interface Consortium (AMIC) will provide corresponding vehicle electronics interfacing applications with the automobile operating system. Consumer interest in the in-vehicle system is expected to be high.

The widespread practice of driving while using mobile telephones and other wireless communications devices has created new highway safety hazards. Research findings from the National Highway Traffic Safety Administration suggest that "as use of in-vehicle wireless communications technology increases there will be an associated increase in crashes if little changes" (U.S. DOT, Investigation of Safety Implications, Nov. 1997). Further research is required to establish standards for safe use of in-vehicle communications devices, including mobile phones, PDAs, and in-vehicle computers.

Conversely, mobile phone users have helped to improve incident management and emergency response times by phoning police immediately following traffic accidents and other highway incidents. Increased use of in-vehicle telematics devices that automatically notify police in the event of an airbag deployment may further improve incident management and emergency response times.

NEXT STEPS

A set of working hypotheses was developed from the MMDI customer satisfaction evaluation findings that may explain why some regions have stronger ATIS customer response than others. The hypotheses describe external conditions for high-demand ATIS markets, ATIS customer characteristics, valued ATIS service features, and traveler behavior in the presence of traffic and transit information. While it is possible that these findings can be generalized to other regions with similar conditions and services, no data support the assertion. Additional ATIS customer satisfaction and traveler behavior research in regions with different network conditions and ATIS services would enrich our understanding of how to accelerate the deployment of ATIS consumer services.

More data are available to describe customer response to ATIS traffic information than customer response to ATIS transit information, partly because of the limited number of ATIS transit services available for evaluation. Further, while the potential size of the traffic information market is quite large and national in scope, the corresponding market for transit information is much smaller. Private sector firms with interest in the ATIS consumer services market may neglect transit information services for lack of market size and lack of consumer response data. In the absence of reliable data describing the impact of ATIS on ridership levels, public transit authorities—faced with competing needs and limited funds—neglect ATIS investments. More customer evaluation data may help to accelerate deployment of ATIS for transit customers and enable a more thorough evaluation of the influence of information on ridership levels, retention, and mode choice.

Finally, many ATIS program managers and several evaluation findings have observed that ATIS services are not well-known among potential customers. Very few, if any, ATIS deployments have been sufficiently well capitalized to afford an advertising campaign. The subsequent lack of awareness among potential ATIS customers has slowed ATIS deployment, as it is difficult for potential investors to distinguish between lack of interest and lack of awareness among travelers. ATIS services require advertising if they are to attract customers and achieve success, whether measured as constituent service or as profits.

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